Renewable and Sustainable Energy Reviews 15 (2011) 2756–2765

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Psychological factors in the diffusion of sustainable technology: A study of Norwegian households' adoption of wood pellet heating

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ARTICLE INFO

Article history:
Received 20 December 2010
Accepted 13 March 2011

Keywords:
Wood pellet heating
Norwegian households
Psychological model
Values
Technology characteristics
Path analysis

ABSTRACT

This paper aims to understand the determinants of the adoption of wood pellet technology for home heating to identify possible strategies against the slow diffusion of wood pellet in Norway. A mail survey of 737 Norwegian households was conducted in 2008, involving wood pellet adopters and non-wood pellet adopters as respondents. An integrated model combining psychological factors (such as intentions, attitudes, perceived behavioral control, habits and norms), perceived wood pellet heating characteristics, and ecological and basic values is applied to predict the installation of a wood pellet stove retrospectively. Results from a path analysis gain empirical support for the proposed integrated model. Wood pellet heating adoption is mainly predicted by a deliberate decision process starting with the evaluation of heating system characteristics, mediated by attitudes and intentions. A lack of perceived behavioral control and behavioral lock-in pose relevant barriers to the adoption process. The influence of norms and values are indirect and only minor in the given market conditions. Therefore, focusing on values or norms should not be of highest priority at the moment, whereas improvement of the subjective evaluation of the functional reliability and the costs related to wood pellet heating should have first priority. The small but significant influence of habitual decision making indicates that presenting alternatives and increase decisional involvement could be other promising strategies to reduce cognitive lock-in in decision-making.

Contents

1. Introduction

Successful diffusion of new technology requires more than just a good new product and a marketing strategy. Consumers' decision making is an important part of this process and deeper understanding of determinants of such a decision lacks often. The aim of the

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[2] The sample used for the present study is to a large extent identical to the sample used for the study reported in Sopha et al. [50]. However, the analysis in the present study is built on different variables.

1364-0321/$ – see front matter
doi:10.1016/j.rser.2011.03.027

present study is to provide a more holistic understanding of mechanisms in the adoption of wood pellet heating in Norway. Heating in the residential sector is an important area to target with respect to energy use. Whereas air conditioning is a main driver of energy use in regions of the world with warm climate, home heating is a significant contributor to energy consumption in regions with rather cold climate. In Norwegian households for example home heating constitutes the largest share of energy consumption in the private sector and accounts for approximately 50% of an average household's energy use [1,2].

Due to the public investment in hydropower between 1960 and 1990 and low electricity prices in the subsequent years the dominant residential heating system in Norway nowadays is electric heating. It might be argued, that with respect to CO_2-emissions the use of electricity for heating is unproblematic if the source is hydropower, but the strong focus on electricity as the primary source for heating has recently lead to problematic situations in Norway: electricity supplied from hydropower is significantly affected by precipitation. When there is low precipitation, for instance in the winter of 2002–2003, so that energy production cannot meet the demand, Norway becomes a net importer of energy. While the Norwegian production of electricity is almost 100% regenerative, the imported energy is generated from various sources including nuclear power and fossil fuel. This is especially problematic when periods of low precipitation overlap with periods of high demand – such as in the unusually cold and dry winter during the first three months of 2010. Electricity prices peaked (the development of electricity prices can be checked at http://www.nordpoolspot.com/) and the demand for alternative heating sources such as ordinary wood stoves increased significantly.

According to Jamasb and Pollitt [3], diversification is the most common suggestion in order to reduce overdependence on particular types of energy supply. However, with respect to climate change this diversification should occur with the least possible impact on CO_2 emissions. Therefore, a combination of different approaches seems to be useful: (a) extending and diversifying the production of sustainable electricity, for example by implementing new hydropower plants, raising efficiency in existing plants, and extending the use of other sources of electricity (wind turbines, wave or tidal power plants, etc.); (b) increasing energy efficiency on the user side and reducing energy demand; (c) implementing heating sources which utilize available alternative sources of energy. Norwegian government has thus supported alternative heating systems for households to reduce electricity consumption and to diversify the heating supply for domestic households. This paper focuses only on the last of the three strategies: implementing alternative heating technologies into the Norwegian market. Despite market interventions, the diffusion of wood pellet heating has however been rather slow in comparison to other new heating technologies like air-to-air-heat pumps. It was reported that only 3 out of 1000 households had pellet stoves installed in 2006 [4].

Although studies of wood pellet heating are very limited, some studies have already investigated the diffusion of wood pellet heating in different countries, i.e. Sweden, Finland, Austria, Denmark and Norway [5–10]. Those studies shared common insights in the sense they identified various factors contributing to the slow diffusion of wood pellets, such as fuel price, high investment cost, lack of technology and service. None has been done however in terms of decision process.

In other behavioral domains like transportation, recycling, water conservation, eco-labeled products, and fuel choice, the study of choice processes has however, been successfully applied to promote more sustainable behavior alternatives (e.g. Johns et al. [11]). A comprehensive study of choice processes with respect to a residential heating system is, however, still lacking.

The present study, therefore, attempts to reveal psychological factors underlying the adoption of wood pellet heating in Norwegian households. It is, therefore, necessary to identify relevant barriers to or determinants of behavioral change in order to achieve changes in the desired way. The present study is not to research the optimal balance of heating systems in Norway, i.e. the authors do not claim that an extremely high adoption rate of wood pellet heating is desirable both from an environmental and economical perspective. The aim is to understand factors contributing to the underutilization of a specific system in a market where diversification would be beneficial. The substantial bio-energy resources available in the form of residues from the Norwegian wood industry makes wood pellet heating especially interesting for the Norwegian market. The basic mechanisms, however, also apply to other underutilized heating systems and the situation in other countries.

2. Theoretical background

Consumer choices have been extensively studied in economic, psychological and sociological research. In the area of residential decision making on energy use, Wilson and Dowlatabadi [12] reviewed theoretical models from four research fields: (a) conventional and behavioral economics, (b) technology adoption theory and attitude-based decision making, (c) social and environmental psychology, and (d) sociology. Also Nyrud et al. [13] analyzed the perception of bio-energy heating in Norway and used a model that included both psychological and system related factors. A similar interdisciplinary approach is followed in this section which outlines relevant theories related to energy related decision making. Three different perspectives are taken to explain adoption of alternative heating systems, one approach analyzing technology characteristics as the main driver, one analyzing psychological variables behind environmental behavior, and one analyzing values as predictors of pro-environmental choices. In the last part of this section an integrated model is proposed that will be tested on data of a Norwegian household sample.

2.1. Technology characteristics predicting adoption

Rogers' Diffusion of Innovation framework [14] which is based on more than 1500 individual studies emphasized that the speed with which individuals pass through the innovation-decision process is partially dependent upon the their perception of an innovation's characteristics. Rogers described five such characteristics: (a) relative advantage compared to conventional products, (b) compatibility with existing values, past experiences and needs of potential adopters, (c) complexity of the system, (d) trialability of the new product, and e) observability of the innovation in the market. Perceived innovation characteristics determined the adoption and rejection of information technology applications in many studies (e.g. Jeyaraj et al. [15]). Rogers' framework also applies to environmental innovations such as environmental heating systems. Tapaninen et al. [16] were able to show that perceived technology characteristics influenced customers' adoption of wood pellet heating in Finland. In addition, Kasanen and Lakshmanan [17] identified costs in terms of annual cost and investment cost as important in adopting a heating system. Another study on the diffusion of wood pellet heating in Sweden [5] recognized that annual heating cost, functional reliability, investment cost and perceived indoor air quality were the most important factors when choosing a heating system. Nyrud et al. [13] found that characteristics of the heating system such as perceived comfort, perceived efficiency, and reliability were the most important predictor of satisfaction with a new wood stove.

Based on former studies regarding heating system choice [5,17], the present study operationalized the specific wood pellet heating characteristics as follows: total cost (investment and operation cost), functional reliability, maintenance/operation work, indoor air quality and fuel supply security in term of price stability. Some of the characteristics proposed by Rogers [14] are discussed in the following sections (past experience, values).

2.2. A psychological approach – the Comprehensive Action Determination Model (CADM)

Psychology has provided a large body of research on why people make choices based on a number of factors including norms, attitudes, intentions, habits, and the perceived ability to act. Several models have been suggested to explain psychological processes preceding behavior (e.g. [18–20]). Nyrud et al. [13] used factors described in the theory of planned behavior [18] to predict people's inclination to continue using wood stove heating. Due to the explorative nature of the present study, the Comprehensive Action Determination Model (CADM) proposed by Klöckner and Blöbaum [21] was selected as the basis for the present study as this model offers its holistic approach to account for a large variety of predictors of behavior. It combines basic assumptions of the theory of planned behavior [18], the norm-activation theory [19], the ipsative theory of behavior [20], findings about the influence of routines and habits on environmental behavior [22] and previous attempts to integrate the respective theories [23,24]. The following paragraph gives a short summary of the basic assumptions of the model (for a discussion of the theoretical background of the model consider the original paper).

The CADM proposes three direct predictors of behavior: intentions, habits, and perceived behavioral control. Intentions capture the deliberate part of the decision making progress. An intention is the person's feeling of being ready and wanting to perform a behavior – in our example buying a wood pellet stove. Perceived behavioral control captures a person's evaluation of his/her ability to perform an intended action. Both factors are described in the theory of planned behavior [18]. Habits capture the influence of behavioral routines and automaticity on behavior. Habits are an important predictor of everyday behavior, their influence on singular decisions such as installing a heating system should be virtually irrelevant. However, as habitual decision making is characterized among other things by simplified decision rules a strategy of not searching for information but just relying on the already known heating system when a decision is due can be considered "habitual" on a very abstract level. Furthermore, a more general perspective might be taken by considering behavior "habitual" if some form of cognitive lock-in can be detected. Johnson et al. [25] demonstrated that familiarity with one online shop – created by learning how to use it in the past – reduces the probability of trying an alternative. This creates loyalty and a lock-in phenomenon that excludes possible competitors. A similar phenomenon has been demonstrated by Gärling et al. [26] in an experimental study of a fictitious energy market. It is though reasonable to assume that also familiarity with one type of heating system (most likely electric heating) may create a cognitive lock-in situation and loyalty towards the established heating system. This phenomenon might act in a comparable way to habits in everyday behavior by reducing the search for and use of information about alternatives [27].

On the second level of the model, intentions are predicted by the person's attitudes towards the behavior, perceived behavioral control, social norms, and personal norms. A similar set of predictors was also described by Bamberg and Möser [23] for other types of pro-environmental behavior. Attitudes – which are the general evaluation of activated beliefs about the behavior and its alternatives – summarize if a person perceives a certain behavior to be positive. Perceived behavioral control does not only influence behavior but also intentions because people might anticipate their limited ability to perform a behavior already before they form an intention. Social norms capture the influence of relevant other people on a decision or, briefly put, the social pressure. While forming an intention, people also anticipate what other people expect them to do, if those people's opinion is relevant for them in this situation, and how much it would psychologically cost them to act against those expectations. Finally, the CADM proposes that intentions are influenced by personal norms, which are feelings of moral obligation to act according to the personal value system. Especially in situations which are morally relevant (like helping other people, decisions which have an impact on following generations, etc.) the influence of personal norms on intentions should be relevant which has been demonstrated by Bamberg and Möser [23]. Those personal norms should over time influence also attitudes, because they act as a moral reference system in the background of decision making that single beliefs might be checked against. Personal norms should be related to social norms as a personal value system is acquired during socialization by interacting with expectations of relevant other people.

The different components of the model are supposed to vary in importance over time, between behavioral domains and between cultures. The CADM has already been successfully applied to explain travel mode choice [21,28] and recycling behavior [29]. The CADM and its theoretical background are discussed in more detail in Klöckner and Blöbaum [21] and Klöckner [30].

2.3. Values and adoption behavior

As already discussed in the introduction, heating system choice has also an environmental dimension which makes the decision at least partly an environmental decision. Hardin [31] acknowledged that environmental decisions were not only related to questions of technical solutions but also to moral responsibility. As environmental behavior is considered a moral issue, values as the most basic psychological representation of moral implications are explored further in the present study as a possible predictor of heating system choice. Many studies have shown that value orientations are relevant determinants of environmental behavior. A study by Clark et al. [32] indicated for example that the bio-altruistic and pro-social values were significant factors in predicting participation in taking part in a green electricity scheme. Poortinga et al. [33] demonstrated the importance of values and worldviews for the support of environmental policy measures and energy saving behavior.

Values are understood as ethical principles that an individual holds and which guide his/her behavior. Values are stable over time and therefore have the power to impact behavior on a very general level. The structure of value systems has been extensively studied in large world-wide studies and one of the most recognized value categorizations traces back to Inglehart [34,35]. Inglehart proposes a two-dimensional structure of the most basic values (survival vs. self-expression values and traditional vs. secular-rational values) which can be further collapsed into one value dimension: materialism (high on traditional and survival values) vs. post-materialism (high on secular-rational and self-expression values). Moral thinking and environmental protection are more likely in a post-materialistic value set. Another tradition of value research is based on the extensive work by Schwartz and Howard [19]. He structured values empirically into ten dimensions which are grouped by similarity into a two-dimensional system. The ten value types can be grouped into higher order dimensions. One of them – self-transcendence which incorporates benevolence and universalism – has been shown to be a good predictor of pro-environmental behavior [36]. More domain specific value systems

have been developed with respect to environmental actions: Dunlap and van Liere [37] introduced an environmental value scale known as the "New Environmental Paradigm", sometimes referred to as a worldview [33]. Initially, the scale was supposed to be unidimensional, however between two and four sub-dimensions have been identified by other researchers. A common labeling of the sub-dimensions is "balance of nature", "human domination" and "limits to growth" [38]. The scale has since its publication gained worldwide attention and correlations with environmental behavior have been documented (see [39] for a review of 30 years of NEP-scale use).

Although the CADM already includes personal norms as proximal stand-in for values, the relation to more general value orientations is still unclear. The Value-Belief-Norm Theory (VBN) developed by Stern et al. [40] attempts to explain how value structures of different generality affect environmental behavior. Stern et al. [40] proposed a value cascade starting with the most general basic value orientation (materialism vs. post-materialism), then taking the intermediate steps of domain specific ecological values (NEP) and personal norms to behavior. In the present study the cascade idea was adopted and basic values were operationalized as the degree of post-materialism in line with Inglehart and Abrahamson [35]. Three subscales of the New Ecological Paradigm were used as operationalization of domain specific values. Self-transcendence can be considered on a comparative level as materialism and was not included in the study.

2.4. An integrated approach to explain wood pellet adoption

The integrated model proposed in the present study combines psychological factors (CADM), perceived wood pellet heating characteristics, and basic and ecological values in (retrospectively) predicting the installation of a wood pellet stove. The model is displayed in Fig. 1. The heating system characteristics and both basic and domain specific values are not supposed to predict the choice directly but mediated by the CADM structure. Values should have an impact on behavior that is mediated by personal norms as proposed in the VBN [40]. The perceived heating system characteristics should influence both attitudes (as they become part of the behavioral belief system) and perceived behavioral control (as they might enhance or reduce the perceived ability to implement a heating technology). The hypotheses derived from the integrated model are as follows,

1. The adoption of wood pellet heating is directly predicted by three determinants: intentions, habits and perceived behavioral control. The influence of habit is however hypothesized to be relatively small and only on the level of extremely simplified decision strategies understood as a cognitive lock-in because the decision on a heating system is not considered as an everyday decision. Intentions should therefore have a strong influence on the behavior. The influence of social and personal norms is indirect and mediated by intentions.
2. Perceived wood pellet heating characteristics influence the choice indirectly, mediated by psychological variables. It is hypothesized that these perceived wood pellet heating characteristics influence the households' evaluation of wood pellet heating (attitudes). Perceived wood pellet heating characteristics could furthermore act as situational constraints that could limit a household's perceived ability to install a certain type of heating system (perceived behavioral control).
3. It is expected that personal norms mediate the relationship between values and intention. Furthermore, personal norms should also be influenced by social norms (pressure from relevant other people).

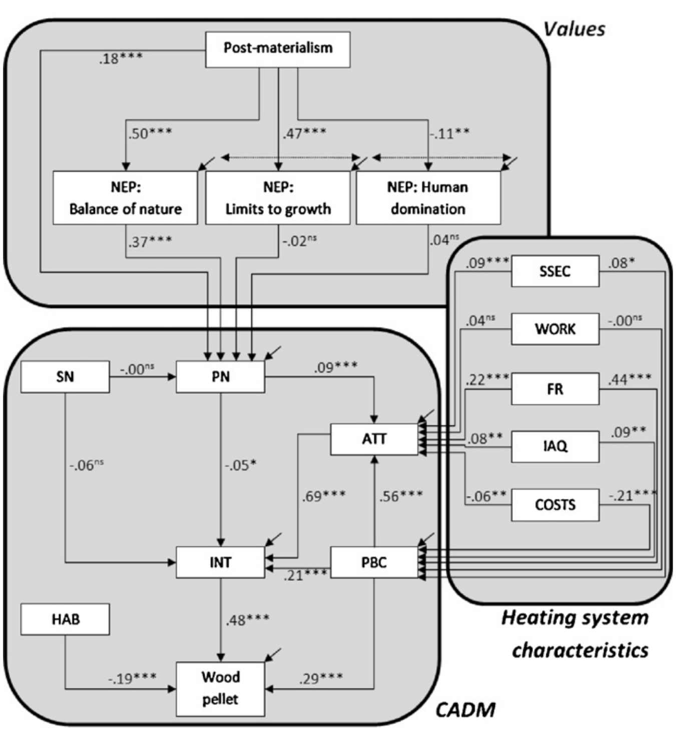

Fig. 1. The tested combination of CADM, heating system characteristics, and basic and ecological values (post-materialism & NEP) to model the decision for wood pellet heating. The displayed numbers are standardized regression weights in a path analysis (N = 737).

3. Method

A quantitative survey was chosen as the method for assessing different proposed components in households' decision making regarding wood pellet heating adoption. The final model was tested against the empirical data with a path analysis without any data driven modifications.[1] The model was not tested as a structural equation model (SEM) with latent variables because most constructs were only measured with one or two indicators which poses a potential threat to an SEM analysis due to under-determination of the latent constructs [41]. The statistical package MPLUS [42] was used for the analysis to deal with the dichotomous nature of the dependent variable and non-normal distributions of single variables (the robust mean and variance adjusted weighted least square estimator [WLSMV] was used). Full information maximum likelihood estimation was applied to deal with missing values. Missing values on exogenous variables resulted in a reduction of the sample size (see below).

3.1. Sample[2]

The present study was conducted by using a mail survey involving 737 Norwegian households. The original sample of 3000 households was constructed of 50% wood pellet users and 50% non-wood pellet users to have a large enough proportion of people that made the decision to install a wood pellet stove already. Hence, the

[1] A residual covariance was modeled for the three sub-dimensions of the NEP scale to cover the theoretical discussion that they might constitute one dimension only.

[2] The sample used for the present study is to a large extent identical to the sample used for the study reported in Sopha et al. [50]. However, the analysis in the present study is built on different variables.

sample of the present study is not representative for the Norwegian population because of the overrepresentation of wood pellet users. The wood pellet group represented almost the complete population of wood pellet adopters in Norway. The non-wood pellet group was drawn as a random sample from the population register. Only house owners were chosen as respondents because they had the authority to make decisions about heating systems independent of other parties. The unit of analysis in our study is the household because a decision regarding a heating system is usually made on household level. One member of the household was asked to answer the paper–pencil questionnaire and the household members were left to decide who is most qualified.

The questionnaires were sent by mail in autumn 2008. After three weeks, the response rates in the wood pellet and non-wood pellet group were 34.6% (519 questionnaires) and 10.3% (154 questionnaires), respectively. A reminding letter containing another copy of the questionnaires was mailed after three weeks. 150 additional responses from the wood pellet group and 137 from the non-wood pellet group were received after the reminder. This resulted in a response rate of 44.6% (669 responses) for the wood pellet group and 19.4% (291 responses) for non-wood pellet group. Several respondents did not answer the entire questionnaire, and therefore the response rate varies for each question. Participants with missing values in exogenous variables had to be excluded from the study so that the final analysis is based on a sample of 737 participants (542 wood pellet users and 195 non-wood pellet users).

A Chi^2 test was conducted to test if the distribution of the 1500 non-wood pellet households in the random sample deviated significantly from the regional distribution of all households in the 19 administrative regions in Norway without a significant result ($Chi^2 = 17.633$; $df = 18$; $p = 0.480$). In other words, the composition of the original sample of non-wood pellet users was representative for the Norwegian population by region. Even though it is not the case for the wood pellet users ($Chi^2 = 488.028$; $df = 13$; $p < 0.001$), the sample for wood pellet users is representative for the Norwegian wood pellet users as it accounts for roughly 80% of all wood pellet users in Norway.

To test possible self-selection effects, a Chi^2 test was also performed for both groups to compare the original and the response sample by region. The tests revealed that there was no statistical difference between the original samples and response samples for wood pellet users ($Chi^2 = 2.031$; $df = 13$; $p = 1.000$) and non-wood pellet users ($Chi^2 = 8.689$; $df = 18$; $p = 0.967$). Thus, a self selection bias could not be found with respect to regional distributions. Other data on the original population to test self-selection bias in the response samples was not available. It might, therefore, be possible that self-selection processes resulted in an undetected bias, especially as the response rate in the two groups was different.

3.2. Measures

The dependent behavioral variable "choice of a wood pellet heating system" was operationalized using membership in one of the two groups in the sample, coded 1 as wood pellet and 0 as no wood pellet use. The group membership therefore represents a real choice of wood pellet heating adoption; the decisional process however is only retrospectively analyzed and the point in time when the households made the decision is unknown and most likely varying. Personal norm (PN), attitudes (ATT), perceived behavioral control (PBC), and intention (INT) were measured with two items each adopted from the work of Klöckner and Blöbaum [21] modified with respect to heating system choice and then translated to Norwegian. Habit (HAB) was in the present study operationalized as utilizing a strategy of repeating the decision for the previous heating system by asking the participants whether they implement a choice strategy to just rely on their old heating system without consideration of alternatives, coded as 1, or not, coded as 0. This can be considered a behavioral or cognitive lock-in. It has to be noted that the operationalization of habits in the present study is therefore not comparable to the measurement of habits discussed in the paper by Klöckner and Blöbaum [21]. Social norms (SN) were measured as the estimated degree of other people's influences when the household was making a decision (0%, 20%, 40%, 60%, 80%, and 100%). This is again a measure that deviates from previous measures of social norms. Indicators of functional reliability (FR), required work (WORK), indoor air quality (IAQ), total cost (COSTS) and fuel supply security (SSEC) were adapted from Moore and Benbasat [43], modified according to the needs of the present study and then translated to Norwegian. The items used can be found in Appendix A. The answering scales in the present study were used in accordance with the original studies the items were derived from: a 7-point Likert scale from "totally disagree" coded as 1 to "totally agree" coded as 7 was used on all items except the habits and the social norms item. The extent of materialistic or post-materialistic value orientation (PMAT) was measured using 6 indicators on a 5-point Likert scale and adapted from Vogel [44]. The higher the score is the higher is the degree of post-materialism. The New Environmental Paradigm (NEP) scales were adopted from Lalonde and Jackson [45] who based their scale on the original work by Dunlap and van Liere [37]. Each NEP subscale (balance of nature: NEP_{BON}; limits to growth: NEP_{LTG}; and human domination: NEP_{HD}) was measured by two items. For the path analysis sum scores of multi-item constructs were calculated. Table 1 displays the basic statistics of the variables in the path analysis and internal consistencies of the scales (Cronbach's alpha). Most scales have an acceptable to very good internal consistency; the indoor air quality scale, however, has limited internal consistency. Due to the confirmatory nature of the study, no regrouping of items was conducted before the path analysis was applied. Appendix B displays the correlation of all variables used in the path analysis. It has to be noted that some correlations are very high (especially between INT, ATT and PBC) which might indicate a problem with discriminant validity of the measures. Results of a factor analysis conducted during construction of the scales point into the same direction indicating that the indicators of INT, ATT and PBC load all high on the same factor. As the operationalizations of the three variables were chosen in line with standard procedures we decided not to collapse the scales into one and to keep them as they are. A high correlation between these variables that are theoretically supposed to have a strong relation might also be meaningful.

Table 1
Means and standard deviations of the variables in the path analysis, Cronbach's alpha is given where the variable is the sum score of at least two items ($N = 737$).

	M	SD	Cronbach's alpha	Range of score
INT	10.23	3.87	0.92	2–14
HAB	0.15	0.36	Single item (dichotomous)	0/1
PBC	10.98	3.25	0.77	2–14
ATT	10.60	3.20	0.82	2–14
PN	9.50	2.90	0.82	2–14
SN	2.39	1.07	Single item	1–6
SSEC	8.41	2.97	0.82	2–14
WORK	7.77	3.22	0.74	2–14
FR	10.62	2.69	0.85	2–14
IAQ	9.87	2.56	0.51	2–14
COSTS	7.12	3.19	0.66	2–14
NEP_{BON}	8.34	1.62	0.63	2–10
NEP_{LTG}	8.01	1.75	0.67	2–10
NEP_{HD}	4.78	2.17	0.71	2–10
PMAT	23.15	3.51	0.66	6–30

Table 2
Unstandardized and standardized regression weights, standard errors, *p*-level and estimated R^2 of the path analysis ($N = 737$).

	B	SE	Beta	p	R^2
Wood pellet ← INT	0.15	0.01	0.48	<0.001***	
Wood pellet ← HAB	−0.66	0.15	−0.19	<0.001***	
Wood pellet ← PBC	0.10	0.02	0.29	<0.001***	
Wood pellet					0.56
INT ← PN	−0.06	0.03	−0.05	0.027*	
INT ← SN	−0.23	0.12	−0.06	0.053	
INT ← ATT	0.81	0.04	0.69	<0.001***	
INT ← PBC	0.25	0.03	0.21	<0.001***	
INT					0.75
ATT ← SSEC	0.09	0.03	0.09	<0.001***	
ATT ← WORK	0.04	0.03	0.04	0.144	
ATT ← FR	0.27	0.03	0.22	<0.001***	
ATT ← IAQ	0.10	0.03	0.08	0.001**	
ATT ← COSTS	−0.07	0.03	−0.06	0.007**	
ATT ← PBC	0.56	0.02	0.56	<0.001***	
ATT ← PN	0.11	0.03	0.09	<0.001***	
ATT					0.65
PBC ← SSEC	0.09	0.04	0.08	0.010*	
PBC ← WORK	−0.00	0.04	−0.00	0.942	
PBC ← FR	0.55	0.04	0.44	<0.001***	
PBC ← IAQ	0.12	0.04	0.09	0.006**	
PBC ← COSTS	−0.22	0.03	−0.21	<0.001***	
PBC					0.40
PN ← SN	−0.00	0.09	0.00	0.973	
PN ← NEP_{BON}	0.67	0.07	0.37	<0.001***	
PN ← NEP_{LTG}	−0.03	0.06	−0.02	0.666	
PN ← NEP_{HD}	0.05	0.04	0.04	0.198	
PN ← PMAT	0.15	0.03	0.18	<0.001***	
PN					0.22
NEP_{BON} ← PMAT	0.23	0.02	0.50	<0.001***	
NEP_{BON}					0.25
NEP_{LTG} ← PMAT	0.24	0.02	0.47	<0.001***	
NEP_{LTG}					0.22
NEP_{HD} ← PMAT	−0.07	0.02	−0.11	0.002**	
NEP_{HD}					0.01
NEP_{BON} ←→ NEP_{LTG}	0.92	0.08	0.46	<0.001***	
NEP_{BON} ←→ NEP_{HD}	−0.21	0.09	−0.08	0.021*	
NEP_{LTG} ←→ NEP_{HD}	−0.01	0.11	−0.00	0.936	

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

4. Results

Table 2 and Fig. 1 display the results of the path analysis. All of the hypothesized influences show as expected with exception of the social norms, two out of three NEP subscales, and the amount of maintenance and operational work. The integrated model can explain 56% in the variance of underlying continuous probit variable constituting the choice of wood pellet heating and therefore qualifies as a good approach to predict the choice of wood pellet heating. The most important predictor of the decision to use wood pellet heating is the intention. The influence of perceived behavioral control is weaker but significant as is the negative influence of habits.

Attitudes are by far the most important predictor of the intention to use wood pellet heating followed by perceived behavioral control. The influence of perceived behavioral control on intentions is to a larger extent mediated by attitudes (due to their substantial overlap this is not surprising – see Appendix B). The influence of personal norms on intention is also mediated by attitudes. However, an unexpected negative direct effect of personal norms on intention remains. Against our expectations social norms are not related to personal norms and intentions. One out of three NEP sub-scales (balance of nature) predicts personal norms significantly; the others fail to show a direct effect. There is, however, a very high correlation between NEP_{BON} and NEP_{LTG}, which indicates that the expected three-dimensional structure has to be rejected. The degree of post-materialism, as expected, has an indirect effect on personal norms, mediated by NEP_{BON}, but a significant direct influence remains. All technology characteristics but the amount of work related to wood pellet heating have the expected influences on attitude and perceived behavioral control. Functional reliability has the strongest impact, especially on perceived behavioral control. Substantial amounts of variance are predicted in most dependent variables in the path analysis.

Model fit indices presented in Table 3 indicate an acceptable fit of model and empirical data. This means that the proposed model

Table 3
Model fit indices of the tested path model.

Index	
Chi²/df/p	106.772/36[a]/<0.001
CFI	0.949
TLI	0.936
RMSEA	0.052[b]

[a] Due to the WLSMV-estimator the degrees of freedom for the Chi^2-test have to be estimated (see the technical appendix to the MPLUS users guide for more advice [42]).
[b] Due to the WLSMV-estimator a confidence interval for the RMSEA index could not be computed.

is capable of reproducing the observed variance–covariance matrix to a large extend.[3]

5. Discussion

The goal of the present study was to test a proposed complex model of technological and psychological characteristics predicting wood pellet heating adoption in Norwegian households. The integrated model combining CADM, perceived technological characteristics of wood pellet heating as well as values was tested against empirical data using a path analysis. The results (see Table 2) indicated that the model received reasonable support by the empirical data and is able to explain 56% of variation in the variable underlying heating system choice. This implies that the integrated model is a promising approach to explain choice behavior of wood pellet heating and analyzing its diffusion processes.

Although the analysis is based on correlational data only and thus does not allow inference of causal relations the results (Fig. 1) seem to indicate, that the adoption of wood pellet heating is a process that is mainly guided by the "technology characteristics translated into attitudes translated into intentions" chain. The process is to a large extent characterized by rational decision making, weighing up the pros and cons of different heating technologies with respect to their technological characteristics. Not all information is, however, processed along the lines of attitude formation: a substantial amount of information processing seems to go along perceived control. Some of the heating system characteristics (functional reliability and costs) seem to be even more important for forming a representation of control, which means how much a person feels capable of showing a behavior, than they are for forming an attitude. That means that even if a possible adopter of wood pellet heating formed a positive attitude towards wood pellet heating the subjective evaluation of functional reliability and costs could interfere with acting according to the positive attitude. Another important finding is that even if the influence of habits, as expected, is small in magnitude compared to the impact of intentions and perceived behavioral control, it has still a significant impact. Even if habits are conceptualized differently in the present study than in previous studies [21], the reduction of complexity in the decision making process indicated by using a repetitive strategy was demonstrated to have an impact in disfavor of new technologies. This may indicate a cognitive lock-in of some people, which was also demonstrated in previous research [25,26]. Traditionalized heating system choices (such as the reliance on electrical heating in Norway) could therefore interfere with the adoption process. General values influence behavior mediated by several sub-steps, confirming that values affect behavior indirectly through specific values, norms and intention [33,46]. The influence of values and norms on the decision process is minor (although mostly as theoretically expected). Personal norms have only a weak impact on attitudes. The mediated impact of basic or environmental values is even smaller. This means that strengthening environmental values and norms seems not to be a promising driver of the diffusion of wood pellet heating, at least not in a situation with such limited market share and weak social support of wood pellet users.

Although the analysis confirmed most of our hypotheses stated in the theoretical background, some results were unexpected. Those will be addressed in the following paragraph. Firstly, there is the unexpected negative direct influence of personal norms on intention (parallel to the expected positive influence mediated by attitudes). This seems to be a slight negative suppressor effect that should not be interpreted theoretically.[4] The correlation table in Appendix B indicates that the bivariate correlation between heating system choice and personal norms is positive as expected. Similar suppressor effects have been shown before [24] and might have been caused by a relevant overlap between personal norms and other variables. Secondly, social norm lacks to have a significant influence on personal norm and intention. This contradicts the results by Ek and Söderholm [47] revealing that social influence affects individual consumption behavior in the green energy market. We attribute our finding to the unusual operationalization of social norms in the present study (estimated amount of influence), which was chosen due to needs outside the scope of the analysis reported here. As the direction of the social influence is not specified it could be that social influence in favor and in disfavor of wood pellet heating even out. Thirdly, at least the missing influence of the NEP subscale "limits to growth" on personal norms can be explained by the obvious lack of a three dimensional structure. Balance of nature and limits to growth correlate so strongly that they cannot be differentiated into two factors. This finding is much in line with arguments presented by Dunlap et al. [48]. They propose that the structure of the NEP is one dimensional (in spite of other research findings) and that the very common two dimensional structure with "human domination" as additional factor is a methodological artifact caused by the negative wording of the subscales items. This would explain why all shared variation between personal norms and the NEP subscale is captured by the strongest subscale "balance of nature". Finally, the insignificant relation between the evaluation of work connected to wood pellet heating and attitudes and perceived behavioral control could mean that this aspect is not relevant in the evaluation process or that variation between people on this aspect is to such a large amount overlapping with the other aspects that its influence is sufficiently captured by them (see Appendix B for correlations of "work" with the other heating system characteristics).

Although the study presented here offers an interesting and promising perspective on the adoption of wood pellet heating, some limitations have to be discussed: firstly, the adoption process is modeled retrospectively which makes the validity of the results questionable to a certain extent. Maybe, wood pellet users adapted their cognitive mind set, their attitudes, etc. after they made the decision for wood pellet heating. As the temporal order of events in the present study is reversed in the analysis and data is analyzed on a correlational basis, no conclusion about causal relations can be drawn. Thus, a study following people through the process of deciding for a heating system and measuring the variables several times throughout the process would be extremely insightful. We are nevertheless convinced that the structure of the model holds, because it could be replicated in other domains (travel mode choice and waste recycling) were behavior was predicted prospectively [21,29]. Secondly, although variance in attitude is predicted by 65% and variance in perceived behavioral control by 40%, the selection of heating system characteristics is far from being complete. Other aspects like design, image, space in the house to install the

[3] The fit of the model was evaluated using different types of fit indexes including the relative *Chi*-square (normal or normed *Chi*-square), comparative fix index (CFI), Tucker–Lewis Index (TLI), and root mean square error of approximation (RMSEA). Different researchers have recommended using relative *Chi*-square to degrees of freedom ratio as low as 2 or as high as 5 to indicate a reasonable fit [51–53]. The ratio in the present study is approximately 3 and lies within this margin. The Chi^2-test comes out significant due to the sample size. CFI and TLI were chosen as additional model fit indices because they are independent of sample size or less sensitive to sample size. CFI and TLI should be equal to or greater than 0.90 in order for the model to be accepted [54], and in this case is satisfied for both measures. Following convention a RMSEA less than or equal to 0.08 were judged as providing a reasonable fit to the data, again was met in this analysis.

[4] Such suppressor effects are common in analyses using the WLSMV estimator.

stove, etc. might be important that were not included in the present study. Rakos [49] reported that one of the factors that contributed to the success of wood pellet heating in Austria were technological characteristics, such as fully automatic operation, beautiful design, and the high quality and comfort offered by wood pellet heating. Thirdly, it has to be analyzed how specific the results are to Norway and the wood pellet technology studied here. Can the proposed model be applied to diffusion of other technologies? Can it be applied to other countries? We expect that the model structure should be stable over products and countries, but that the importance of the different components might vary. The impact of habits should for example be the stronger, the more often implementation behavior is shown. Maybe, the influence of values and norms is stronger in technology domains that are closer to people's self definition (for example in medicine). Maybe, social norms have a stronger influence when the market share of a product is higher, especially if the product becomes part of a certain life style (as the iPhone for example).

For the diffusion of wood pellet technology in Norway the results may have important implications. If the Norwegian government wants to speed up the diffusion process, improvement of the subjective evaluation of the functional reliability and the costs related to wood pellet heating should have first priority. Focusing on values or norms should not be of highest priority at the moment, but might be later, when the market share is larger and a significant number of people use wood pellet heating that could form a social reference group proposing the environmental values of wood pellet heating. Then people with most post-materialistic values would be the most likely candidates to adopt wood pellet heating. Considering the small but significant influence of habitual decision making it could be important to motivate people to actually actively make a choice when they are about to install a new heating system and reduce cognitive lock-in. Procedures reducing customer loyalty in decision making which might be considered as an example of such a lock-in have been discussed in Gärling et al. [26]. Presenting alternatives and increase decisional involvement could be other promising strategies.

Acknowledgement

Financial support provided by Norwegian University of Science and Technology (NTNU), Norway, is gratefully acknowledged.

Appendix A.

Likert scale coded as 1 (totally disagree)–7 (totally agree)
Personal Ecological Norm

1. Due to my values/principles I feel personally obliged to use an environmentally friendly heating system.
2. The aspect of environmental protection in deciding for a heating system is solidly anchored in my value system.

Intention

1. When I decide next time for a new heating system, my intention to use wood pellet heating is strong.
2. I intent to use wood pellet heating.

Attitudes

1. It would be good using wood pellet heating.
2. It would be valuable to use wood pellet heating.

Perceived behavioral control

1. If I wanted I could easily use wood pellet heating.
2. It would be easy to meet my need for home heating using wood pellet heating.

Functional reliability – the degree to which wood pellet heating is reliable

1. I think that wood pellet heating results in less breakdowns.
2. Wood pellet heating is reliable.

Indoor air quality – the degree to which wood pellet heating provides high indoor air quality

1. Poor quality of indoor air is produced by wood pellet heating.
2. Using wood pellet heating results in clean and not too dry indoor air.

Total cost (investment and operational cost) – the degree to which wood pellet heating is affordable

1. Wood pellet heating is too expensive to have.
2. I believe that wood pellet heating would cost more than I could afford.

Work related to operation and maintenance – the degree to which wood pellet heating requires work related to operation and maintenance

1. I would have to do operation and maintenance work if I am using wood pellet heating.
2. Lots of work related to operation and maintenance is required for wood pellet heating.

Supply security – the degree to which the fuel for wood pellet heating is easy to find with stable price

1. It is easy to find the fuel with the stable price for wood pellet heating.
2. The fuel for wood pellet heating is available with almost the same price.

Likert scale coded as 1 (totally disagree) – 5 (totally agree)
Degree of post-materialism value
How should our society look?

1. A society that gives higher priority to environmental protection than to economic development.
2. A society that tries to create prosperity but not at the cost of risk.
3. A society that in the first instance emphasizes job satisfaction as the fruit of human labor.
4. A society in which individuals are judged primarily on the basis of their human qualities.
5. A society with numerous possibilities for citizens to take part in the political process.
6. A society that makes an effort to maintain nature as it is.

New Environmental Paradigm (NEP)
Balance of nature:

1. Human must live in harmony with nature in order to survive.
2. Humankind is severely abusing the environment.

Limits to growth:

1. The earth is like a spaceship with only limited room and resources.
2. There are limits to growth beyond which our industrialized society cannot expand.

Human domination:

1. Humankind was created to rule over the rest of nature.
2. Plants and animals exist primarily to be used by humans.

Appendix B. Correlation table of scales and constructs (*N* = 737).

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)
(a) Wood pellet[a]																
(b) INT	0.71^{***}															
(c) HAB	-0.29^{***}	-0.17^{**}														
(d) PBC	0.66^{***}	0.75^{***}	−0.08													
(e) ATT	0.61^{***}	0.85^{***}	-0.15^{**}	0.77^{***}												
(f) PN	0.13^{**}	0.17^{***}	-0.10^{*}	0.16^{***}	0.24^{***}											
(g) SN	0.10^{*}	-0.11^{**}	-0.26^{***}	-0.09^{**}	−0.06	−0.01										
(h) SSEC	0.29^{***}	0.40^{***}	0.00	0.35^{***}	0.40^{***}	0.17^{***}	-0.10^{**}									
(i) WORK	-0.29^{***}	-0.36^{***}	0.02	-0.37^{***}	-0.36^{***}	-0.10^{**}	0.07^{*}	-0.27^{***}								
(j) FR	0.37^{***}	0.58^{***}	0.05	0.59^{***}	0.62^{***}	0.22^{***}	-0.08^{**}	0.42^{***}	-0.51^{***}							
(k) IAQ	0.34^{***}	0.38^{***}	-0.12^{*}	0.33^{***}	0.37^{***}	0.13^{***}	-0.07^{*}	0.26^{***}	-0.36^{***}	0.39^{***}						
(l) COSTS	-0.41^{***}	-0.39^{***}	0.16^{**}	-0.40^{***}	-0.38^{***}	-0.09^{**}	0.08^{*}	-0.31^{***}	0.42^{***}	-0.33^{***}	-0.29^{***}					
(m) NEP_{BON}	0.03	0.08^{*}	-0.12^{*}	0.08^{*}	0.13^{***}	0.41^{***}	0.05	0.04	0.03	0.03	0.05	-0.10^{**}				
(n) NEP_{LTG}	0.03	0.03	−0.06	0.06	0.11^{**}	0.27^{***}	0.05	0.05	−0.01	0.08^{*}	0.03	−0.05	0.59^{***}			
(o) NEP_{HD}	0.04	0.07^{*}	0.07	0.06	0.04	−0.01	−0.02	0.06^{*}	−0.01	0.02	−0.00	0.09^{**}	-0.12^{***}	−0.04		
(p) PMAT	0.03	0.07	−0.10	0.07	0.14^{***}	0.34^{***}	0.00	0.13^{***}	−0.04	0.10^{**}	0.08^{*}	−0.03	0.49^{***}	0.48^{***}	−0.05	

[a] The variable of wood pellet is dichotomous: no variance is calculated, correlations are based on logits.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

References

[1] Larsen BM, Nesbakken R. Formålsfordeling av husholdningenes elektrisitetsforbruk i 1990 og 2001. Økonomiske Analysis, 4/2005; 2005. Available from: http://www.ssb.no/emner/08/05/10/oa/200504/nesbakken.pdf [in Norwegian].
[2] REMODECE Project; 2006. Retrieved in October 2009. Available from: http://www.sintef.net/Olje-og-energi/SINTEF-Energiforskning-AS/Prosjektarbeid/USELOAD-/REMODECE/.
[3] Jamasb T, Pollitt M. Security of supply and regulation of energy networks. Energy Policy 2008;36(12):4584–9.
[4] Statistics Norway 2006. Retrieved in June 2008. Available from: http://www.ssb.no/.
[5] Mahapatra K, Gustavsson L, Madlener R. Bioenergy innovations: the case of wood pellet systems in Sweden. Technology Analysis & Strategic Management 2007;19(1):99–125.
[6] Rakos C. The diffusion of biomass district heating in Austria, Project Report to the European Commission. In: Institute of Technology Assessment. Vienna: Austrian Academy of Sciences; 1995.
[7] Egger C, Öhlinger C, Dell G. Wood Pellets-tomorrow's fuel. Renewable Energy World, September–October 2003. Available from: http://www.investinnorthbay.ca/workforce/doc/BIO_MASS/Wood%20Pellets%20Tomorrow's%20Fuel.pdf.
[8] Alakangas E, Paju P. Wood pellets in Finland-technology, economy and market. OPET Report 5, VTT Processes, Jyväskylä; 2002. Retrieved in October 2007. Available from: www.tekes.fi/opet/pdf/OPET_report5_june2002.pdf.
[9] Nashoug H, Pedersen FD. Opportunities and barriers for development of a Norwegian wood pellet market. Thesis, Institutt for Økonomi og Samfunnsfag, NLH; 2004 [in Norwegian].
[10] Bjerg J, Evald A. Denmark – market and technology trends in the Danish pellets market. In: European Pellets Conference. 2004.
[11] Johns KD, Khovanova KM, Welch EW. Fleet conversion in local government: determinants of driver fuel choice of bi-fuel vehicles. Environment and Behavior 2009;41(3):402–26.
[12] Wilson C, Dowlatabadi H. Models of decision making and residential energy use. Annual Review of Environmental Resource 2007;32:169–203.
[13] Nyrud AQ, Roos A, Sande JB. Residential bioenergy heating: a study of consumer perceptions. Energy Policy 2008;36:3169–76.
[14] Rogers E. Diffusion of Innovations. 4th ed. New York: Free Press; 1995.
[15] Jeyaraj A, Rottman J, Lacity M. A review of predictors, linkages and biases in IT innovation adoption research. Journal of Information Technology 2006;21(1):1–23.
[16] Tapaninen A, Seppänen M, Mäkinen S. Characteristics of innovation: a customer-centric view of barriers to the adoption of a renewable energy system. International Journal of Agile Systems and Management 2009;4:98–113.
[17] Kasanen P, Lakshmanan TR. Residential heating choices of Finnish household. Economic Geography 1989;65(2):130–45.
[18] Ajzen I. The theory of planned behavior. Organizational Behavior and Human Decision Process 1991;50:179–211.
[19] Schwartz SH, Howard JA. A normative decision-making model of altruism. In: Rushton JP, editor. Altruism and helping behavior. Social, personality and developmental perspectives. Hillsdale, New York: Erlbaum; 1981.
[20] Frey BS. Ipsative and objective limits to human behavior. Journal of Behavioral Economics 1988;4:229–48.
[21] Klöckner CA, Blöbaum A. A comprehensive action determination model - towards a broader understanding of ecological behavior using the example of travel mode choice. Journal of Environmental Psychology 2010;30:574–86.
[22] Verplanken B, Wood W. Interventions to break and create consumer habits. Journal of Public Policy & Marketing 2006;25(1):90–103.
[23] Bamberg S, Möser G. Twenty years after Hines, Hungerford, and Tomera: a new meta-analysis of psycho-social determinants of pro-environmental behaviour. Journal of Environmental Psychology 2007;27:14–25.
[24] Heath Y, Gifford R. Extending the theory of planned behaviour: predicting the use of public transportation. Journal of Applied Social Psychology 2002;32:2154–89.
[25] Johnson EJ, Bellman S, Lohse GL. Cognitive lock-in and the power law of practice. Journal of Marketing 2003;67:62–75.
[26] Gärling T, Gamble A, Juliusson EA. Consumers' switching inertia in a fictitious electricity market. International Journal of Consumer Studies 2008;32:613–8.
[27] Verplanken B, Aarts H. Habit attitude, and planned behaviour: is habit an empty construct or an interesting case of goal-directed automaticity? European Review of Social Psychology 1999;10:101–34.
[28] Klöckner CA, Friedrichsmeier T. A multilevel approach to travel mode choice – how person characteristics and situation specific aspects determine car use in a student sample. Transportation Research Part F: Traffic Psychology and Behaviour 2011, doi:10.1016/j.trf.2011.01.006.
[29] Klöckner CA, Oppedal IO. General versus domain specific recycling behaviour – applying a multilevel comprehensive action determination model to recycling in Norwegian student homes. Resources, Conservation and Recycling 2011;55:463–71.
[30] Klöckner CA. Understanding the purchase of organic food – a theoretical framework from a psychological perspective. Food Science Central online features; 2010. Available from: http://www.foodsciencecentral.com/fsc/ixid15967.
[31] Hardin G. The tragedy of the commons. Science 1968;162:1243–8. Accessed in November 2009. Available from: http://www.sciencemag.org/cgi/content/full/162/3859/1243.
[32] Clark CF, Kotchen MJ, Moore MR. Internal and external influences on pro-environmental behaviour: participation in a green electricity program. Journal of Environmental Psychology 2003;23:237–46.
[33] Poortinga W, Steg L, Vlek C. Values environmental concern, and environmental behavior: a study into household energy use. Environment and Behavior 2004;36:70–93.
[34] Inglehart R, Rabier J-R. Political realignments in advanced industrial society: from class-based politics to quality-of-life politics. Government and Opposition 1986;21:456–79.
[35] Inglehart R, Abramson PR. Measuring postmaterialism. American Political Review 1999;93(3):665–77.

[36] Hansla A, Gamble A, Juliusson A, Gärling T. Psychological determinants of attitude towards and willingness to pay for green electricity. Energy Policy 2008;36:768–74.

[37] Dunlap RE, Van Liere KD. The "New Environmental Paradigm": a proposed measuring instrument and preliminary results. The Journal of Environmental Education 1978;9(4):10–9.

[38] Geller J, Lasley P. The new environmental paradigm scale: a reexamination. Journal of Environmental Education 1985;17(1):9–12.

[39] Dunlap RE. The new environmental paradigm scale: from marginality to worldwide use. The Journal of Environmental Education 2008;40(1): 3–18.

[40] Stern PC, Dietz T, Abel T, Guagnano GA, Kalof L. A value-belief-norm theory of support for social movements: the case of environmentalism. Human Ecology Review 1999;6(2):81–96.

[41] Marsh HW, Kau K-T, Balla JR, Grayson D. Is more ever too much? The number of indicators per factor in confirmatory factor analysis. Multivariate Behavioral Research 1998;33(2):181–220.

[42] Muthén LK, Muthén BO. Mplus user's guide. 5th ed. Los Angeles, CA: Muthén & Muthén; 1998–2007.

[43] Moore G, Benbasat I. Development of an instrument to measure the perceptions of adopting an information technology innovation. Information Systems Research 1991;2(3):192–222.

[44] Vogel S. Environmental attitudes and behaviour in the agricultural sector empirically determined by use of an attitude model, Diskussionpapier Nr. 32-W-94; 1994. Accessed in June 2008. Available from: http://www.boku.ac.at/wpr/papers/d_papers/dp_cont_html.

[45] Lalonde R, Jackson EL. The new environmental paradigm scale: has it outlived its usefulness? The Journal of Environmental Education 2002;33(4):28–36.

[46] Nordlund AM, Garvill J. Value structures behind environmental behavior. Environment and Behavior 2002;34:740–56.

[47] Ek K, Söderholm P. Norms and economic motivation in the Swedish green electricity market. Ecological Economics 2008;68:169–82.

[48] Dunlap RE, Van Liere KD, Mertig AG, Jones RE. Measuring endorsement of the New Ecological Paradigm: a revised NEP scale. The Journal of Social Issues 2000;56(3):425–42.

[49] Rakos C. Pellet – a new star on the renewable energy sky. The Austrian Energy Agency E.V.A.; 2009. Accessed in November 2009. Available from: http://www.bioheat.info/pdf/rakos_success_wp.pdf.

[50] Sopha BM, Klöckner CA, Skjevrak CA, Hertwich EG. Norwegian households' perception of wood pellet stove compared to air-to-air heat pump and electric heating. Energy Policy 2010;38(7):3744–54.

[51] Wheaton B, Muthén B, Alwin DF, Summers GF. Assessing reliability and stability in panel models. In: Heise DR, editor. Sociological methodology. San Francisco: Jossey-Bass; 1977.

[52] Schumacker RE, Lomax RG. A beginner's guide to structural equation modeling. 2nd ed. Mahwah, NJ: Lawrence Erlbaum Associates; 2004.

[53] Marsh HW, Hocevar D. Application of confirmatory factor analysis to the study of self-concept: first- and higher order factor models and their invariance across groups. Psychological Bulletin 1985;97:562–82.

[54] Fan X, Thompson B, Wang L. Effects of sample size, estimation method, and model specification on structural equation modeling fit indexes. Structural Equation Modeling 1999;6:56–83.